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Cotton DISEASES AND METHODS OF CONTROL

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Crop losses caused by cotton diseases constitute an enormous, hidden toll exacted from the grower. Annual losses from all diseases over a 29-year period have averaged 15 percent of the total crop.

Cotton plants are especially susceptible to diseases during the seedling stage, but they can be and often are attacked at all stages of growth.

Many cotton diseases are now being largely controlled by resistant varieties, seed treatments, soil fumigation, or cultural practices. Others, such as verticillium wilt, ascochyta blight, and rhizoctonia seedling blight, are becoming more widespread and destructive.

To combat these diseases, the cotton grower needs to know what organisms cause them, what their symptoms are, and what the most effective control measures are. This bulletin gives such information on the more important cotton diseases. Color photographs have been used to illustrate several of the diseases which would be difficult, if not impossible, to distinguish from one another in black and white reproductions.

CONTENTS

	Page		Page
Seedling diseases	1	Cotton rust	13
Nematode injury	2	Ascochyta blight	14
Fusarium wilt	5	Minor leaf spots	15
Verticillium wilt	7	Acromania, or crazy top	16
Cotton root rot	8	Potash hunger, or "rust"	17
Bacterial blight	10	Crinkle leaf, or manganese toxicity	18
Boll rots	11	Lightning injury	18
Internal collar rot	12	2,4-D injury	19

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Cover Illustration—Rotation of cotton with Hubam clover has controlled cotton root rot on right side of the center row where the rotation was used.

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Cotton DISEASES and METHODS of CONTROL

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Figure 1.—Cotton plants infected with seedling diseases before or soon after emergence have dark-brown or reddish areas on the seedling leaves or at the base of the stem.

SEEDLING DISEASES

Seedling diseases are caused by a number of seedborne and soil-inhabiting fungi and bacteria which are most harmful during periods of cold, damp weather. Terms such as damping-off, sore shin, and seedling blight are used as collective descriptions of the diseases.

The anthracnose fungus is the main disease-producing organism responsible for seedling blight and damping-off in the cotton-growing States east of the 40-inch rain belt of Oklahoma and Texas. Ascochyta blight also occurs in the same general area. Other important organisms that attack cotton seedlings are the sore shin fungus and the bacterium causing bacterial blight. These are found throughout the Cotton Belt and often cause serious damage, particularly in the Western States. Several other disease organisms attack seedlings and cause losses in some areas, but generally they are of minor importance in the complex of seedling diseases. Most of the organisms that damage seedlings also affect cotton plants at later stages of growth.

[1] This bulletin is a revision of a previous edition prepared in 1935 by David C. Neal and W. W. Gilbert.

Losses from seedling diseases may occur before or after emergence; reductions in yield may be as high as 15 percent.

Symptoms

Seedlings affected by anthracnose have reddish or dark-brown lesions on the stems below the soil line and frequently on the roots (fig. 1). The seed leaves (cotyledons) may also display brownish spots that enlarge before the plant wilts and dies.

Ascochyta blight symptoms first appear as small, round, brown-colored spots on seed leaves and young true leaves.

The sore shin fungus causes dark- to reddish-brown cankers on the stems near the soil surface, usually within 5 to 10 days after planting. In severe attacks, the cankers encircle the stems or penetrate so deeply that the plants fall over and die.

The first symptoms of bacterial blight are small, round, water-soaked lesions on the seed leaves as they emerge from the seedcoat. These lesions serve to infect the developing true leaves, terminal buds, and the main stem.

Control

The most practical method of control of anthracnose, ascochyta blight, and bacterial blight in the seedling stage is proper treatment of the seed with a recommended disinfectant. It is also well to delay planting in the spring until temperatures are favorable enough for rapid plant development.

There are many recommended seed disinfectants available which are sold under various trade names. Consult your county agent or State agricultural experiment station for the material recommended in your particular area and also for rates of application. The materials can be applied as dusts or slurry (thin, watery) mixtures.

For average farm conditions or even for small-scale commercial operations, a homemade, rotating barrel or metal-drum mixer is a satisfactory and inexpensive machine for mixing dust and seed. The mixer is filled one-half to two-thirds full of seed and the required amount of disinfectant is added. The mixer is then closed and turned slowly for about 5 minutes or until the dust and seed are thoroughly mixed. Plans for constructing homemade mixers are available from most county agents.

For large-scale seed treatment, several commercial machines, using either dust or slurry mixtures, are on the market.

No satisfactory chemical or fungicidal control measure has yet (1954) been developed for sore shin of cotton. However, certain cultural practices will reduce losses. These include planting on well-pulverized, raised seedbeds, use of certified seed treated for control of seedborne diseases, delaying of planting until the soil warms up, and speeding up germination by using reginned or acid-delinted seed and liberal fertilization.

NEMATODE INJURY

Several species of nematodes (microscopic eelworms) are injurious to cotton plants. The most important of these is the root-knot nematode, which enters the roots and feeds from the inside. Other nematodes that feed on roots from the outside, such as the meadow nematode and the sting nematode, also cause damage.

Figure 2.—Belowground symptoms of root-knot nematode infestations are conspicuous, light-colored galls on the roots.

Figure 3.—When a cotton plant is severely affected by root knot, the root system is deformed and plants are stunted and slow in growth.

In the majority of soils in the rain belt, nematode attack is often accompanied by fusarium wilt. With increased numbers of nematodes wilt is progressively more severe.

The root-knot nematode, because of its general distribution, is by far the most destructive of the nematodes attacking cotton. It is found in soils of light texture throughout the Cotton Belt. The damage caused by root knot varies from slight stunting of the plants to complete destruction of the crop in localized areas of severe infestation.

An adult female root-knot nematode with mature eggs can often be seen with the unaided eye, being about the diameter of a small pinhead and pearl white in color. The microscopic larvae which hatch from the eggs enter the tips of small roots, move for a short distance in the root tissue, and then become stationary. They feed on the root cells by puncturing their walls. This feeding stimulates the growth of the cells to greatly enlarged size and results in knotlike galls on the roots.

The life cycle of the root-knot nematode from egg to adult is 30 to 35 days under favorable conditions. One female may produce more than a thousand eggs. With such a short life cycle and high reproductive powers, population buildups are rapid.

Figure 4.—The cotton plant in the center has been attacked by fusarium wilt. Leaves display the characteristic yellowing and wilting.

Of the free-feeding nematodes, the sting nematode, or coarse-root nematode, occurs in localized areas and is very destructive to other crops beside cotton. This eelworm does not enter roots but feeds on root cells from the outside. The fine roots are pruned off, leaving many openings through which the wilt fungus can enter.

The meadow, or root-rot, nematode is prevalent throughout the Cotton Belt. It causes damage by pruning off the small rootlets of young plants as they develop. The constant loss of feeder roots causes stunting of the plants. Heavy infestations may kill many plants.

Symptoms

The symptoms of root knot belowground are conspicuous galls on the roots. Galls may become as large as one-half inch or more in diameter. They are lighter in color than the healthy root tissue (fig. 2). Severe infestations of the root-knot nematode restrict the growth of the entire root system (fig. 3). The larger roots become shortened and branched, often terminating in a small tuft of short, fine roots. The smaller roots become more abundant, crooked, and knotted. Aboveground symptoms are stunting and slower growth of the plants.

Belowground symptoms of injury by the free-feeding nematodes are the absence of fine rootlets leading out from the main roots and their branches. Plants exhibit varying degrees of stunting above the ground and in severe attacks may be killed.

Control

The application of soil fumigants and the use of resistant crops in rotation with cotton are of considerable benefit in controlling nematodes. Fusarium wilt is also controlled indirectly by destroying the nematodes.

Fumigants giving satisfactory control of nematodes are ethylene dibromide and D-D mixture (1,3-dichloropropene – 1,2-dichloropropane). Economical control can be obtained by applying the material

in the row at 6 to 8 gallons per acre a few days before planting. Such applications kill the nematodes in a zone near the young plants. Once the plants are established and growing rapidly, later infestations do little damage. If applications are made only along the rows, they should be repeated each year.

Rotating cotton with crops that are resistant to nematode injury is a cultural practice of value in reducing fusarium wilt losses and increasing yields. Crops that reduce root-knot nematodes are grasses, sorghum, small grains, corn, peanuts, crotalaria, velvetbeans, alfalfa, and resistant cowpeas.

FUSARIUM WILT

Fusarium wilt, or cotton wilt, is caused by a fungus that survives indefinitely on organic matter in the soil. The disease is prevalent from Virginia to Texas. It causes the most serious injury to cotton plants in the acid, light-textured soils of the Southeastern States.

Fusarium wilt may attack cotton seedlings, but it usually appears when the plants are more mature. The disease causes stunting and death of the plants. Average annual loss from the disease is estimated at 4 to 5 percent of the total crop.

The fusarium wilt fungus enters cotton roots mainly through wounds caused by nematodes but can also penetrate uninjured roots. Once inside the root the fungus moves upward through the woody part of the plant and into the leaf stems (petioles) and veins. It occasionally enters the bolls and penetrates

Figure 5.—These cotton plants show the advanced stages of fusarium wilt. The plant on the right has lost all of its upper leaves, lower leaves have wilted and are dropping, and bolls have opened prematurely. The plant on the left has been completely killed in an earlier stage of growth.

into the seed; infested seed often serve to spread the disease to disease-free areas.

Symptoms

The earliest symptoms of fusarium wilt are the yellowing and browning of seed leaves and small true leaves. Affected leaves eventually die and fall off. The bare stems soon blacken and die.

In older plants the first symptom may be stunting, followed by yellowing, wilting (fig. 4), and dropping of most of the leaves (fig. 5). Leaf discoloration first appears around the edges near a vein. When a stem or branch is cut crosswise, a brown or black ring is usually found just beneath the bark. Wilting usually occurs gradually. However, after a rain that follows a dry period, plants may wilt suddenly and in large numbers. Wilted plants fruit earlier than normal plants and the bolls are smaller and open prematurely.

Control

Fusarium wilt is most satisfactorily controlled by growing wilt-resistant varieties, such as Coker 100 Wilt, Stonewilt, Empire, White Gold Wilt, Pandora, or Plains. There are many other commercial varieties with varying degrees of tolerance to the disease.

Because nematode infestations injure the roots of cotton plants and permit the easier entrance of the wilt fungus, control of nematodes (p. 4) is often of major importance in controlling fusarium wilt.

Several cultural practices are beneficial in the control of wilt. These include (1) clean summer fallowing, (2) rotation with nonsusceptible crops such as sorghum, peanuts, crotalaria, corn, and small grains, and (3) application of balanced fertilizers with sufficient potash to prevent potash deficiency. Heavy applications of potash tend to reduce losses; heavy applications of nitrogen tend to increase losses.

Figure 6.—A healthy cotton plant and one severely injured by verticillium wilt. The diseased plant has shed most of its leaves and bolls; remaining leaves exhibit the characteristic mottling near their edges.

VERTICILLIUM WILT

Verticillium wilt of cotton is caused by a soilborne fungus. The disease occurs throughout the entire Cotton Belt, but is most serious in the lower Mississippi Valley and the irrigated areas of the Southwest. Plants may be attacked at any stage of development, and especially during cool, wet weather.

The disease causes stunting of plants (fig. 6) and damage to the cotton fibers. Where infestations are heavy, losses of the crop may be as high as 50 percent; losses of 10 to 15 percent are common. Fiber damage causes an increase in the number of neps. This increases the manufacturing waste and lowers the quality of the yarns produced.

Symptoms

When cotton plants are attacked by verticillium wilt in the seedling stage, the seed leaves and young true leaves become yellowish and dry out rapidly (fig. 7). Infected seedlings usually die.

Young wilt-affected plants exhibit varying degrees of stunting, depending on the stage of development. After the seedling stage the outstanding symptom of verticillium wilt is the pale yellow (chlorotic) marking on the leaf margins and between the principal veins. This marking gives a distinct mottled appearance to the leaves (figs. 8 and 17).

Plants attacked at late stages of growth usually display the mottled marking first in the lower leaves. It spreads to the middle and upper leaves later in the growing season. The chlorotic areas gradually become larger and paler and finally die. Severely affected plants will shed all of their leaves and most of the young bolls (fig. 6). They may, however, survive throughout the growing season and will sometimes send up sprouts from their bases.

Verticillium wilt is sometimes difficult to distinguish from fusarium wilt. Leaf markings are sometimes similar and the internal tissues are discolored by both diseases, particularly at the base of the stem. However, the discoloration produced by verticillium wilt is usually more evenly distributed through the stem center (stele) and lighter brown than the discoloration produced by fusarium wilt. (See fig. 21.)

Control

The most resistant or tolerant varieties adapted to a particular location should be planted in fields that are infested with verticillium wilt. Varieties of American-Egyptian, Pima, Sea Island, and some South American cottons generally have a high degree of resistance to the disease.

Most of the commercial upland varieties are extremely susceptible to verticillium wilt. Despite this,

Figure 7.—Yellowish, dry areas near the leaf margins are typical symptoms of verticillium wilt in young cotton plants.

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Figure 8.—Cotton plants attacked by verticillium wilt during late stages of growth display a pale-yellow, mottled marking on the leaves.

some progress has been made in developing more tolerant varieties, particularly in the Southwest. The variety Acala 4-42, developed at the U. S. Cotton Field Station at Shafter, Calif., has some tolerance to the disease. Another wilt-tolerant variety, Acala 1517 W. R., has been developed and made available to growers through breeding research at the U. S. Cotton Field Station, State College, N. Mex.

Of the upland cottons adapted to the southeastern United States none have a high degree of tolerance to verticillium wilt. However, fusarium-resistant varieties, such as Coker 100 Wilt, Coker 4-in-1, Empire, and Plains, also display some tolerance to verticillium wilt. Such varieties should be planted where soils are infested with the verticillium fungus. Further research is being conducted on the development of wilt-resistant varieties for the Southeastern States.

Certain cultural practices have been shown to reduce the damage caused by verticillium wilt. In the Southwest frequent light irrigations after the plants begin to set fruit permit more rapid warming of the soil and thus help to control the disease. The increased soil temperature that results from planting on high ridges also gives some degree of control.

Some crop rotations are helpful in minimizing damage caused by verticillium. In the Southwest a rotation consisting of dry fallow for 1 year followed by barley or a barley-Hubam clover mixture reduces the percentage of infected plants in the first cotton crop. Alfalfa has also been used with some benefit in rotations immediately before cotton.

Other cultural practices are of value in reducing damage from verticillium. The use of good field sanitation measures to eliminate diseased cotton stalks, leaves, and stem trash is helpful. Planting the cotton thicker than the conventional spacing has reduced losses in the irrigated Southwest.

COTTON ROOT ROT

Cotton root rot is caused by a soilborne fungus that affects many other plants native to several areas in the Southwest. The area of greatest damage is in the blackland prairie of Texas. Elsewhere the disease is confined primarily to calcareous and alkaline soils.

Spread of the disease in the United States appears to be limited by natural barriers—on the east by acid soils, on the north by low temperatures, and along the California border by a range of sandhills and desert mountains.

Root rot usually becomes active in cottonfields about 2 or 3 months after planting. In the lower Rio Grande Valley of Texas, plants may be killed early in May. Farther

Figure 9.—All the aboveground parts of cotton plants infected with cotton root rot wilt and die.

north the first symptoms may not appear until the middle of June. After the disease first appears, it spreads rapidly to neighboring plants, especially during warm weather and immediately following rains. By late summer or early fall many brown, irregular patches of dead plants may be seen in infested fields.

In those areas where cotton root rot occurs, it is one of the most destructive diseases. In general the heaviest losses are experienced during wet years.

Symptoms

The first symptom of cotton root rot above the ground is a slight, uniform yellowing or bronzing of the young leaves at the top of a plant. This is followed by sudden wilting and death of the entire plant, usually within 2 or 3 days (fig. 9). As the plant dries out, the leaves become brown and brittle, but remain attached. Belowground the roots are covered by a fine white mold and brown, threadlike strands (figs. 10 and 16).

Because of these characteristic symptoms, root rot is rather easy to distinguish from other diseases.

Control

Practical control of cotton root rot at present appears to lie in the use of various combinations of cultural practices. The use of disinfectants or fungicides is not economically feasible because of the cost of materials or methods of application under field conditions. No varieties of cotton that are resistant to the disease have been found.

Cultural practices showing beneficial results in reducing root rot losses and increasing yields are the addition of phosphate and manure, early fall plowing, deep tillage, rotation with legumes, sorghum, small grains, or corn, and

the use of early maturing varieties.

In the central blacklands of Texas, partial control of root rot has been obtained through a cotton-Hubam clover rotation. (See illustration on cover page.) Hubam planted as a winter cover crop and turned under before cotton is planted gives good control. Even better results are obtained if the clover crop is permitted to grow to maturity, and turned under after the seed is harvested.

In the irrigated Southwest, root rot has been effectively reduced by applying large amounts of barnyard manure or green manure in deep furrows. The furrows are covered over, beds are prepared above them, and the land is irrigated a few weeks before planting.

Figure 10.—Roots of cotton plants infected with root rot are covered with white mold.

BACTERIAL BLIGHT

Bacterial blight is prevalent throughout the cotton-growing areas of the United States. The disease can attack any aboveground part of cotton plants and at any stage of growth. It may cause seedling blight, leaf infections, stem rot, and boll decay. Bacterial blight injuries are described by various names, depending on the part of the plant attacked. Descriptive terms often used are angular leaf spot, boll rot or boll blight, vein blight, and "black arm." (See fig. 19.)

Losses from bacterial blight are greatest in the Southwest, particularly in the irrigated areas of Arizona and New Mexico and in areas of low rainfall in Texas and Oklahoma. In certain areas of the Pecos Valley and on the High Plains of west Texas and Oklahoma, losses of as much as 25 percent of the crop have been attributed, directly or indirectly, to bacterial blight. In the South Central States losses occur following widespread winds and rainstorms which disseminate the bacteria and produce conditions favorable for infection.

Symptoms

The first symptoms of bacterial blight are small water-soaked lesions on the seed leaves and young true leaves of seedlings. From these primary lesions the bacterial infection may be spread by irrigation water or windblown rain to leaves higher on the plant or to surrounding plants (fig. 11). The lesions on the leaves turn brown or black when dry. If the stems and fruiting branches are infected, black, elongated lesions ("black arm") are produced. The black-arm phase of the disease is not common on the varieties grown in the Southeast, but the upland and American-Egyptian varieties commonly grown in the Southwest are extremely susceptible. Severe infection causes shedding of leaves,

squares, and young bolls in older plants and thus reduces the yield.

Control

Methods of control of bacterial blight at present depend largely on eliminating the sources of infection on the seed and in the field. A combination of delinting seed with sulfuric acid and treatment with a recommended disinfectant is widely used in areas where serious losses have occurred.

Other methods of controlling blight are the use of seed grown in disease-free fields and the destruction in early fall of infected crop residues by deep, clean plowing. Volunteer seedlings should also be destroyed in the spring before planting.

BOLL ROTS

Boll rots are caused by a large number of parasitic organisms. These organisms may be grouped into two classes—the primary invaders that penetrate the uninjured boll and the secondary invaders that enter through wounds or openings made by the primary organisms. In the first group is the fungus causing anthracnose and the bacterium causing bacterial blight. The second group is composed entirely of weakly parasitic or saprophytic fungi.

Boll rots are especially severe in the Mississippi Valley States, where frequent rains maintain high humidity and cause rank growth.

Boll rots cause losses by reducing yields, by staining and reducing the strength of the lint, and by infecting the seed with disease-producing organisms which cause seedling blights in the following crop. (See fig. 20.) During periods of unfavorable weather, boll rots may destroy or reduce the value of 10 to 25 percent of the crop.

Figure 11.—Angular leaf spot (dark-colored areas between the veins of cotton leaves) is a typical symptom of the advanced stage of bacterial blight.

Symptoms

The symptoms of anthracnose on cotton bolls are small, round, water-soaked spots, which enlarge and become sunken and brownish in color. A sticky mass of spores is formed over the surface of lesions on the bolls.

Bacterial blight infections on bolls are first shown by shiny, circular lesions. These later become sunken and browned and blackened. Infected bolls become deformed and open prematurely and abnormally (fig. 12).

Control

Bottom defoliation is an effective method of reducing boll rot losses from anthracnose and some of the other rots. Good defoliation can be obtained by applying calcium cyanamide dust at the rate of 30 pounds an acre. Removal of the leaves permits rapid drying of the bolls and lint after rains and dews and reduces boll and fiber losses.

Other practices of value in reducing boll damage are the planting of cotton varieties with smaller leaves and more open growth, limiting vegetative growth of the plant by avoiding overirrigation and reducing nitrogen, controlling insects that damage bolls, and controlling grass and weeds that hinder air circulation. Partial control of boll rots can often be achieved through seed treatment. (See p. 2.)

INTERNAL COLLAR ROT

Internal collar rot is the name given to a fungus disease that causes seedling blight and rotting of the root at the collar and below. The disease occurs in Arizona, New Mexico, west Texas, Mississippi, and Tennessee. Stands of cotton are reduced through killing of seedlings and mature plants. Cool, wet weather favors seedling infection and rapid spread of the disease.

Symptoms

Seedlings attacked by internal collar rot are stunted and generally unhealthy in appearance. Leaves are often small, pale green, and show marginal browning and burn-

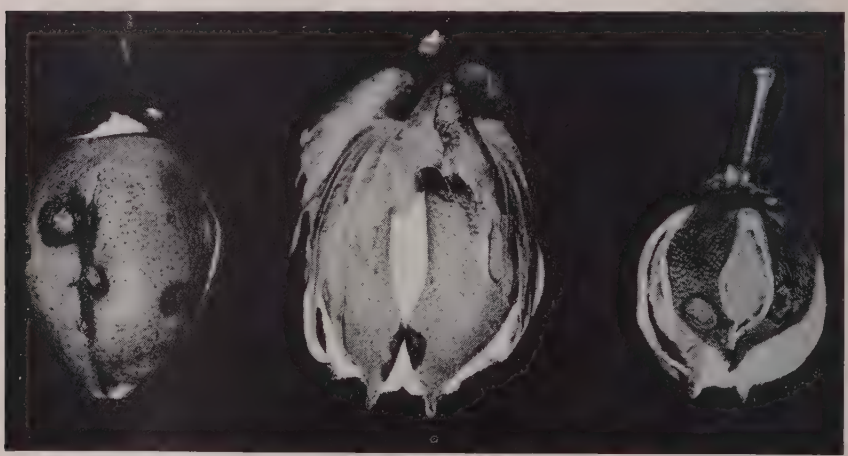

Figure 12.—Attacks by the bacterial-blight organism severely damage cotton bolls and prevent them from opening normally. Infected spots also provide openings for other organisms to enter and damage the cotton fibers.

ing. If the weather remains cool, most of the infected seedlings die; if temperatures rise the infection is arrested and many of the affected plants appear to recover. During midsummer little evidence of the disease is present on the surface of the root. If the root is cut, however, a cylinder of infected tissue surrounded by healthy tissue is usually found.

Late in the summer or early fall, when lower temperatures prevail again, the infection usually becomes active and causes further damage. It is at this later stage of the disease when the characteristic collar rot develops. This is an abnormal swelling of the main root beginning at the collar and extending 3 to 6 inches below the ground level. Internal tissues in the affected region are brown or purplish black in color (fig. 13).

Control

Although studies have been made, no control measures for internal collar rot have been developed up to the present time (1954).

COTTON RUST

True rust of cotton is caused by a fungus that attacks the leaves of cotton plants. The disease is quite distinct from the so-called cotton rust caused by potash deficiency (see p. 17).

True cotton rust is confined to areas in the Southwest where the only known host plants—several species of grasses, primarily gramas—occur. Infecting spores are produced on the susceptible grasses in or near cottonfields and are carried over winter on diseased grass residues.

Moisture in the form of rain or dew is necessary for infection to occur on either cotton or grass, and the disease builds up as the growing season progresses. Under the low annual rainfall in the Southwest the grasses normally make limited growth and produce only a few spores. Under irrigation, however, they grow quite vigorously in fields and along ditchbanks and provide an abundant supply of spores.

All varieties of upland and American-Egyptian cotton are susceptible to this disease. Losses as high as 25 percent of the crop have been reported from certain areas of Arizona.

Symptoms

The distinctive symptoms of true cotton rust is the development of orange-colored spots on the leaves (figs. 14 and 15). These usually appear early in July in those parts of the Southwest where the disease occurs.

Control

The best method of control of cotton rust consists of clean cultivation to eliminate the host grasses.

Figure 13.—Internal collar rot can be recognized by the abnormal swelling and internal discoloration of the upper portion of cotton roots.

Figure 14.—Severe infestations of true cotton rust produce many orange-colored lesions on the leaves.

ASCOCHYTA BLIGHT

Ascochyta blight, or wet-weather blight, is a fungus disease that is found throughout the humid cotton-growing area. The most serious outbreaks of the disease have occurred in the Piedmont areas of the Carolinas and Georgia and in the northern parts of Alabama, Mississippi, and central Arkansas.

The disease organism lives over winter on infected plant residues and on seed that has not been disinfected. In the spring, new infections are produced on seedlings or young plants. Plants 3 to 8 weeks old are particularly susceptible and are often killed during cool, wet weather. Complete loss of stand from this disease may occur during periods of unfavorable weather, but ordinarily plants recover and resume normal growth with the return of good weather.

Symptoms

The first symptoms of ascochyta blight are small, round, brownish spots on the seed leaves and small true leaves of the seedlings. At later stages of growth, spots on the leaves become more numerous and ashy colored. Brownish, elongated cankers may also develop on the stem.

Control

Excellent control of ascochyta seedling blight is possible through seed treatment and crop rotation. Rotation eliminates the infecting spores overwintering on cotton plant refuse and seed treatment greatly reduces primary infections on seedlings. Partial, but generally satisfactory, control is obtained by plowing old cotton stalks and leaves under deeply in the fall

Figure 15.—This cotton plant has been infected by the cotton rust fungus. The orange-colored spot on the underside of the leaf is characteristic of the disease.

and planting flat to leave the refuse buried.

Although no cotton varieties have enough resistance to withstand seedling blight attacks, Empire, Deltapine 15, and Stoneville 2B have shown slightly more resistance to cankers on the stem in older plants than other commercial varieties.

MINOR LEAF SPOTS

In addition to the organisms previously mentioned as causing leaf spots, there are several others—primarily fungi—of relatively minor importance. Leaf spots caused by these fungi are quite common in cottonfields toward the end of the growing season. The amount of damage caused usually is not of sufficient importance to warrant control measures.

Alternaria leaf spot is typified by an abundance of papery, rusty-brown spots of irregular size and shape. As the spots enlarge they form a series of concentric markings that become more apparent late in the growing season. In fields where this disease occurs in conjunction with potash deficiency, there may be considerable defoliation.

Cercospora leaf spot is extremely common on cotton plants at various stages of growth. The spots are usually small and irregular in

Figure 16.—Cotton root rot produces brown, threadlike strands on the roots and limits their development.

shape, and have purple borders and white centers. After the spots reach maximum size, the centers often fall out, producing a shothole effect. The disease seldom causes much defoliation.

Frosty blight, or areolate mildew, appears in late summer on cotton plants growing in damp localities. The spots are small and angular, and are white on the underside of the leaves.

ACROMANIA, OR CRAZY TOP

A growth disorder of cotton, commonly referred to as crazy top, occurs in Arizona and California. The actual cause of crazy top is not known but appears to be related to irrigation practice. The disease is associated with the checking of growth from water shortages and the resumption of growth when abundant moisture is restored.

The more striking and injurious manifestations of crazy top occur in cemented soils or soils with impervious strata. The disease causes sterility and serious reductions in yield in some years. Both upland and American-Egyptian cottons are affected but American-Egyptian appears to be more susceptible.

Symptoms

The term "crazy top" is descriptive of the unusual and abnormal branching and fruiting in the upper part of the cotton plant. Fruiting branches near the top are replaced by vegetative branches which have a strong upright growth (fig. 18).

Plants affected by crazy top may shed most of their buds and young bolls. This shedding may not begin until some of the lower branches and bolls have almost completed normal development. Leaves near the tops of plants are smaller than normal, rounded, cupped, and thickened. Flowers are usually small and in most cases stigmas are de-

Figure 17.—These cotton leaves show the characteristic yellowish markings on their margins and between the principal veins produced by verticillium wilt.

Figure 18.—Crazy top (acromania) causes cotton plants to send up tall vegetative branches. Leaves near the tops are distorted and smaller than normal.

pressed and anthers fail to open. If any bolls are produced, they are likely to be small and malformed and to have few seeds.

Late in the growing season, plants may recover and set a late crop of normal-appearing bolls on the upper branches.

Control

Irrigation practices that tend to promote an even distribution of moisture are effective in controlling crazy top. Cultural practices of benefit include deep tillage and maintenance of organic matter at high levels by rotation with alfalfa.

POTASH HUNGER, OR "RUST"

The disorder caused by potash deficiency and known as potash hunger, or "rust," is not a true rust. The reddish-brown coloring of affected plants late in the season probably suggested the name "rust" which is in common usage among growers. Potash deficiency occurs commonly in the Coastal Plain area of the Cotton Belt and is usually confined to soils of light texture. It may occur on other soil types, however, especially after many years of continuous cropping without addition of potash to replace that removed by the crops.

Symptoms

Soils deficient in potash do not usually produce plants with normal growth. The plants are small and lack a healthy green color. As the season progresses, the leaves become slightly mottled with yellow spots at the margins. These spots gradually enlarge and the edges of the leaves curl downward. Affected leaves become reddish brown, dry up, and fall from the plant prematurely. This early shedding of leaves reduces the size and number of bolls and lowers the yields of cotton.

Control

Potash deficiency can be easily controlled by proper application of the mineral to the soil. Applica-

tions may be in the form of mixed fertilizer high in potash or as side-dressings when nitrogen is applied. Fifty to seventy-five pounds of potash per acre may be required to correct the disorder in severe cases.

CRINKLE LEAF, OR MANGANESE TOXICITY

Crinkle leaf is a nutritional disorder of cotton plants associated with acid soils, calcium deficiency, and excess manganese. The disorder occurs in certain silt loam soils in Louisiana and Arkansas.

The symptoms are puckering, mottling, partial yellowing, and distortion of the young leaves; abnormally thick branching (fasciation); and distortion of buds, flowers, and bolls.

The disease is readily controlled by the application of enough limestone to change the soil reaction about one pH unit. The limestone precipitates the excess manganese out of the soil solution, thereby restoring a better balance between the manganese and other soil nutrients.

LIGHTNING INJURY

Lightning injury to cotton is a common cause of dead areas in a field. This injury is frequently confused with, or thought to be caused by, a disease.

Injured areas, usually found about midsummer or later, are roughly circular in shape and vary in size from a few feet in diameter to much larger.

Plants in the center of an area struck by lightning are usually killed. The leaves and stalks soon turn black, but the leaves cling to the plant for some time. There is usually a zone of plants with diminishing degrees of injury between the dead plants in the center and surrounding uninjured plants. Some of these injured plants may die within a few days; others may live through the season and produce a partial crop after the injury has occurred.

Figure 19.—Bacterial blight symptoms are shown as they appear on a cotton leaf (angular leaf spot), bolls, and stems ("black arm").

Figure 20.—Several kinds of disease organisms may cause boll rots. Severe infestations may penetrate the bolls, stain the lint, and infect the seeds.

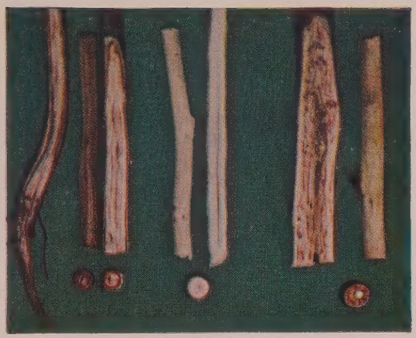

Figure 21.—Internal discolorations of cotton stems produced by fusarium wilt (left) are darker brown than those produced by verticillium wilt (right). Healthy stems are shown in the center.

2,4-D INJURY

The chemical 2,4-D (2,4-dichlorophenoxyacetic acid) is widely used as the active ingredient in weed killers applied for the control of certain broad-leaved weeds and pest plants. Cotton is extremely sensitive to this chemical and is easily affected by drift of dust, spray particles, or vapor from nearby treated areas. The effects of 2,4-D on cotton are sometimes confused with disease symptoms, although they are quite distinctive once identified.

The response of cotton to 2,4-D consists of abnormal growth of foliage, stems, and fruiting structures (fig. 22). The distorted leaves, with scalloped margins, narrow blades, and long tentacle-like tips remain on the plant for many weeks.

The stems of badly affected plants are often swollen and the outer layer (cortex) may break open. Squares and bolls become elongated and malformed. Ordinarily the abnormal squares and bolls are shed, but in some cases they remain on the plant.

Injury from 2,4-D can be minimized by preventing drift of spray, avoidance of contamination of other chemicals used on cotton, and proper cleaning of machinery and containers that have been used.

Figure 22.—Injury to cotton plants by 2,4-D produces abnormal, distorted growth of leaves, stems, and bolls.

Summary of control measures for major cotton diseases

NAME OF DISEASE AND CAUSAL ORGANISM	DISTRIBUTION	SYMPTOMS	CONTROL MEASURES
Anthracnose (the fungus *Glomerella gossypii*).	Primarily in the Southeast but extending into Texas and Oklahoma.	Brownish spots on seed leaves. Stem cankers. Boll rots.	Seed treatment. Destruction of diseased plant residues. Suitable crop rotations.
Ascochyta, or wet-weather, blight (the fungus *Ascochyta gossypii*).	Principally in the Southeastern States.	Reddish-brown spots on leaves. Brownish stem cankers. General unthrifty growth.	Seed treatment. Destruction of diseased plant residues. Suitable crop rotations.
Bacterial blight (the bacterium *Xanthomonas malvacearum*).	Throughout the area where cotton is grown.	Water-soaked spots on seed leaves, leaves, and bolls. Vein blight. Cankers on stalks.	Seed treatment. Use of resistant varieties. Destruction of diseased plant residues.
Boll rots (several parasitic fungi and bacteria).	Throughout the area where cotton is grown.	Sunken spots on surface of bolls. Staining of lint or destruction of interior of bolls.	Seed treatment. Use of bacterial-blight resistant varieties.
Fusarium wilt (the fungus *Fusarium oxysporum* f. *vasinfectum*).	Primarily in the Southeast but extending into Texas and Oklahoma.	Stunting of plant. Yellowing and wilting of leaves. Discoloration of woody portion of stalk.	Use of resistant varieties. Suitable crop rotations. Fumigation to reduce nematodes. Addition of humus to soil. Use of fertilizers high in potash.
Root knot (the nematode *Meloidogyne incognita*).	Throughout the area where cotton is grown but principally on the lighter soils.	Stunting or death of plants. Galls on roots.	Fumigation with locally recommended fumigants. Suitable crop rotations.

Summary of control measures for major cotton diseases—Continued

NAME OF DISEASE AND CAUSAL ORGANISM	DISTRIBUTION	SYMPTOMS	CONTROL MEASURES
Root rot (the fungus *Phymatotrichum omnivorum*).	In the highly calcareous soils of the Southwest.	Slight bronzing of leaves followed by sudden wilting and death of plants.	Fall plowing with phosphate additions. Use of Hubam clover as cover crop. Suitable crop rotations. Heavy applications of organic manures in irrigated areas.
Seedling diseases (several seedborne and soil-inhabiting fungi and bacteria).	Throughout the area where cotton is grown.	Rotting of seed before germination. Death of seedlings before or after emergence.	Seed treatment. Destruction of diseased plant residues. Use of bacterial-blight resistant varieties.
Verticillium wilt (the fungus *Verticillium albo-atrum*).	Throughout the Cotton Belt but primarily in the Mississippi Valley and the irrigated Southwest.	Stunting of plants. Yellowing of leaves. Shedding of leaves, squares, and bolls. Brownish streaks in woody portion of plant.	Use of tolerant varieties. Rotation with grain crops in irrigated areas. Planting on high beds. Increase of plant populations.

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Several of the important cotton diseases can be distinguished from one another only by careful observation of color differences at various stages of growth. To enable the cotton grower to make such distinctions and thus apply effective control measures, a number of the illustrations in this bulletin have been printed in color.

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